Feed Utilization by Cattle

Comparing Systems of Ration Formulation for Dairy Cows

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Introduction

Several systems are being used to estimate requirements, describe feed nutritive value, and formulate rations for dairy cows. Although these systems have a common objective, the approach, complexity, and relative importance of feed and animal attributes differ. Some aspects of these systems have been compared, such as method of defining energy requirements and feed values or specific aspects of protein utilization (microbial yield, fraction of microbes resulting in absorbed amino acids, digestibility of feed and microbial protein, etc.). However, no attempt has been made to compare systems in total to determine if they obtain similar rations when using the same feed ingredients for cows with the same characteristics.

Methods

Four systems were compared: National Research Council using absorbed protein (NRC, 1989); Net Carbohydrate-Protein System (NCPS, Sniffen et al., 1992); Institut National de la Recherche Agronomique (INRA, Jarrige, 1989); and NDF-Energy Intake/Absorbed Protein (NDF/AP, Mertens, 1992, Mertens and Dado, 1993). Using each system, rations were formulated for two multiparous cows (66 months of age), but only the data for the cow in the 10th week of lactation with a body condition score of 3.0, weighing 630 kg, losing .02 kg of weight per day, and producing 43 kg of milk per day containing 3.48% fat and 2.97% protein are presented.

For each cow and system, four rations were formulated using grass hay or alfalfa, corn, or grass silages as the sole forage. Forages were selected for each system that had similar chemical composition. Ground corn, soybean meal (44%CP), and minerals (salt, calcium carbonate, and monosodium phosphate) were the primary concentrates, but fish meal (low degradable protein source), urea (high solubility nitrogen source), animal fat (energy source), and cottonseed hulls (fiber source) were included as potential supplements to meet the requirements of some systems.

Solutions to the NRC and NDF/AP systems were obtained using linear programming with minimum ration cost as the objective function. Forages were given a cost of zero so that the amount of forage in the ration would be maximized. The INRAtion program, which also maximizes forage in the ration, was used to formulate rations using the INRA system. The NCPS is a ration evaluator, not a formulator. An iterative process was used to formulate rations using version 2.12D (06JUL95) software from the University of Pennsylvania with the feed library that was provided. First, each forage was included in the ration as the sole ingredient; then corn and soybean meal were substituted for forage until energy and metabolizable protein requirements were met and intake matched NCPS recommended amounts. Finally, minimal amounts of supplements were substituted for corn or soybean meal to meet the ammonia and peptide requirements of ruminal microorganisms.

Discussion

The NRC system predicted the lowest intake and, although net energy of lactation (NE_L) requirements were lower than other systems, the average energy density of the ration recommended by this system was high and

forage proportion was low (Table 1). Both the NRC and NCPS systems had high metabolizable protein requirements and required higher proportions of protein supplements (soybean and fish meals) in the average ration. The NCPS system yielded rations with the highest content of forages. It also obtained rations that were particularly high in grass forages and low in corn. The INRA and NDF/AP systems estimated similar high intakes of total feed with less protein supplements than required by NRC or NCPS. The NDF/AP system recommended lower levels of grass forage than INRA and NCPS and, because it predicted greater microbial metabolizable production, it yielded rations containing some urea (for the corn silage ration) and less protein supplements. Similar results were obtained for rations recommended for cows with lower production.

Conclusions

Because differences in animals and feeds are small, the discrepancies among systems indicate that there is a need to identify the strengths and weaknesses of each and develop a more accurate system to formulate rations for dairy cows that uses the best aspects of each system.

References

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Table 1. Average kilograms of ingredients in daily rations formulated for a high producing cow using different systems of animal requirements and feed nutritive values.

Ingredient/Nutrient	NRC	NCPS	NDF/AP	INRA
Alfalfa silage	2.52	3.67	3.66	3.99
Corn silage	3.37	4.50	4.04	3.80
Grass silage	2.48	4.50	2.78	3.83
Grass hay	1.98	4.26	2.60	4.03
Corn, ground	9.69	4.03	10.54	7.48
Soybean meal (44% CP)	2.29	2.45	0.56	1.41
Fish meal	0.27	0.27	0.00	0.19
Urea	0.03	0.04	0.19	0.04
Animal fat	0.08	0.00	0.00	0.00
Cottonseed hulls	0.15	0.00	0.00	0.00
Minerals	0.40	0.48	0.44	0.13
Total dry matter	23.27	24.20	24.89	24.89
Forage (% of ration dry matter)	45	70	53	63
NE_L (Mcal)	39.72	41.58	41.29	41.44
Bacterial metabolizable protein	1.655	1.610	1.736	1.217
Dietary metabolizable protein	1.155	1.244	0.942	1.231
Total metabolizable protein	2.810	2.855	2.678	2.448